TAC-TR-62-61

OPERATIONAL TEST AND EVALUATION

AIR REFUELING
F-100 D/F WITH KC-135

DECEMBER 1962

HEADQUARTERS
TACTICAL AIR COMMAND
United States Air Force
Langley Air Force Base, Virginia

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United States Air Force
Langley Air Force Base, Virginia

FOREWORD

Air-to-air refueling with the F-100 D/F aircraft from a KC-135 tanker without the use of afterburner had not previously been explored with 335-gallon drop tanks. The 31st* ~~TAC Ftr Wg~~ and the 407th** ~~Rflg Sq~~ from Homestead AFB, Fla., were tasked to fly 16 tactical fighter sorties and 4 tanker sorties, respectively, to gather data in order to determine the optimum altitude for refueling without the use of afterburners.

Individuals responsible for actual conduct of the test and preparation of this final report are:

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ABSTRACT

Current F-100 air-to-air refueling procedures with the KC-135 tanker are built around using afterburner at 31,000 during hookup. This procedure is wasteful of fuel and does not allow for temperature changes. The proper procedure for maximum economy of fuel is to refuel without afterburner starting at the optimum cruise altitude of the receiver aircraft and using a toboggan procedure until a full offload of fuel is obtained. If clearance procedures restrict the block of altitudes required for a toboggan procedure or cell integrity is required, then a constant refueling altitude is obtained from the appropriate F-100 D/F military climb chart. This altitude is obtained by considering the maximum weight of the aircraft after refueling and adding or subtracting the appropriate gross weight for temperature above or below a standard day. This adjusted gross weight is used to enter the military thrust climb chart for the appropriate drag configuration to the "standard day cruise ceiling". Optimum refueling capabilities are directly proportional to this "standard day cruise ceiling" with one exception - - adjustment for tanker weight. If the tanker aircraft is heavy (240,000 pounds) the optimum altitude is 500 feet below this "standard day cruise ceiling". As the tanker weight is reduced by each 40,000 pounds, the refueling altitude can be increased by 1000 feet.

The confusion in the past as to the optimum altitude to refuel stems from the fact that a change of 20°C. temperature changes the optimum refueling altitude 8000 feet. This temperature change at the same time changes the optimum cruise altitude. The temperature must be used both to compute the refueling altitude and the cruise altitude in order to obtain the full capability of both the receiver and tanker aircraft.

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1. <u>BACKGROUND</u>. Insufficient flight test data has been obtained for optimum use of the F-100 D/F aircraft with 335 gallon drop tanks while refueling with the KC-135 aircraft. "Stay-on" III did not fully explore refueling without afterburner. Current procedures in TACM-55-15 require the use of afterburner power when refueling above 24,000 feet. Pilots have reported that the 24,000 foot restriction can be raised. The use of afterburner power seriously affects the fuel consumption of the F-100 aircraft which, in effect, directly affects the KC-135 tanker capability. By raising this maximum altitude of 24,000 feet without the use of afterburner, our refueling and deployment capability can increase immeasurably.

2. <u>DESCRIPTION OF TEST ITEMS</u>. The 335 gallon drop tank is the elongated 275 drop tank that has been designed for an added fuel load without the detrimental drag experienced with the 450 gallon drop tank. The F-100 D/F aircraft is a standard Air Force aircraft that utilizes the probe to air-to-air refuel. The KC-135 aircraft is a standard Air Force aircraft that has a modified boom incorporating a drogue to receive the probe of the receiver aircraft.

3. <u>PURPOSE OF THE TEST</u>. To determine the optimum altitude for non-afterburner refueling of the F-100 D/F aircraft from the KC-135 tanker. Receiver configuration will include two 335 gallon drop tanks plus a centerline type VII pylon.

4. <u>SCOPE OF THE TEST</u>. This test evaluated the following unknown areas:

a. Optimum altitude for an F-100 aircraft to non-afterburner refuel from tanker gross weights of approximately 252,000, 210,000 and 164,000 pounds.

b. Ability of the receiver aircraft to initiate re-hookup at 33,300 and 35,100 pounds gross weight (approximately 2,000 pounds external and 3,700 pounds external fuel, respectively).

c. Performance with 20° of flaps while refueling at 280 KIAS and 300 KIAS.

d. Effects of downwash by application of full power on the outboard tanker engines while reducing the inboard engine power to maintain 280 KIAS and 300 KIAS, respectively.

e. Effect each 5° temperature has on maximum altitude obtainable.

f. Effects of refueling with boom extended at various trail angles and distances.

5. CONCLUSIONS AND RECOMMENDATIONS.

a. Conclusions:

(1) 24,000 feet is not the maximum altitude for refueling the F-100 D/F aircraft without afterburner.

(2) Temperature is the most influential single factor that controls the maximum altitude for non-afterburner refueling.

(3) For each 40,000 pounds that the tanker gross weight is reduced, 1000 feet can be added to the refueling altitude.

(4) The toboggan method is feasible and will allow the receivers to refuel at a higher altitude than can be accomplished at a constant altitude even with four receivers taking on a full load of fuels from one tanker.

(5) Present directives call for a cruise altitude that at only 10°C. above standard is 7500 feet higher than optimum cruise.

(6) 300 knots tanker indicated airspeed is not the optimum airspeed for refueling.

(7) The existing refueling techniques and directives outlined for the F-100 restrict the total capability of the aircraft.

(8) The use of 20° of flaps at any airspeed between 260 and 300 KIAS resulted in too much drag to be of any value.

(9) Varying the power on the tanker engines had no noticeable effect on receiver control during transfer.

(10) The optimum boom position is full length on the boom at maximum deflection down (38°) and deflected in azimuth 6° to the tanker's starboard side.

(11) Power changes by the tanker aircraft need to be smooth or the receiver aircraft will fall off.

(12) The use of afterburner power can be used for refueling if necessary.

(13) Approximately 200 pounds of fuel is saved each minute when refueling with military power instead of afterburner power. Two aircraft buddy refueling with a KC-135 tanker requiring three inflight refuelings would save 12,000 pounds of fuel and allow an increase in range of approximately 420 miles.

b. Recommendations:

(1) A refueling chart (Appendix IV) that incorporates all variables associated with non-afterburner refueling including receiver and tanker gross weight, temperature and drag configurations should be used to obtain the optimum constant altitude for refueling.

(2) Forecast temperature should be utilized by planners to determine the maximum altitude for refueling without afterburner with the F-100 D/F and the KC-135 aircraft.

(3) The tanker gross weight should be considered for the optimum refueling altitude and 1000 feet for each 40,000 pounds decrease in tanker gross weight should be added to the refueling altitude.

(4) Include the toboggan method of refueling in future planning if no altitude restrictions are imposed upon the refueling area or if cell integrity is not required.

(5) Use either the "Limited Altitude Profile" or the "Maximum Efficiency Toboggan Profile" according to altitude restrictions imposed upon the route being flown. (See Mission Profile Planning, page 24).

(6) 290 knots tanker indicated airspeed is the optimum airspeed for refueling.

(7) After coordination with SAC, TACM 55-15 and SACM 55-9 should be changed to incorporate the recommendations outlined in this report for the F-100 D/F aircraft.

(8) Do not use wing flaps while refueling.

(9) The tanker aircraft should use normal power on all engines.

(10) All refueling with the F-100 D/F be conducted with the boom at full length, maximum deflection down (38°), and deflected in azimuth 6° to the tanker's starboard side.

(11) Power changes by the tanker aircraft should be smooth and a loss of airspeed should be sacrificed instead of adding power.

6. TEST RESULTS AND DISCUSSION.

a. Schedule of Events: One complete mission will be flown each day for a period of four days commencing on Tuesday, 25 Sep 62, and ending on Friday, 29 Sep 62. One mission will include one KC-135 tanker, two F-100F's and two F-100D's. Each aircraft will refuel three times per sortie; once at 28,000 or 26,000, once at 29,000 or 27,000 and finally on a light tanker at 31,000 or 28,000 feet. Deviations from these altitudes will be made while airborne to obtain the optimum altitude for the respective tanker gross weights. At T/O + 1+30 two designated receivers will flight test the possibility of refueling at 280 KIAS and 300 KIAS with and without the use of 20° of flap while varying power settings on the inboard engines of the tanker.

Monday, 24 September 1962 - 1330L - General briefing for all receiver pilots involved in the test program.

Tuesday, 25 September 1962 - 0900L - Flight briefing for tanker and receiver personnel involved in the daily program.

1300 - TOT for tanker

1306 - TOT for receivers

1800 - Debriefing and data collection

Wednesday, 26 September 1962 - 1000L - Flight briefing for tanker and receiver personnel involved in the daily program.

1300 - TOT for tanker

1306 - TOT for receivers

1800 - Debriefing and data collection

Thursday, 27 September 1962 - 1515L - Flight briefing for tanker and receiver personnel involved in the daily program.

1815 - TOT for tanker

1821 - TOT for receivers

2315 - Debriefing and data collection

NOTE: To reduce the possibility of an aircraft incident all receivers will hook up and receive a full fuel load at 26,000 feet, 27,000 feet, and 28,000 feet as would be accomplished during a deployment. By eliminating the intentional disconnect portion of the test, pilot fatigue during the night refueling will be greatly reduced.

Friday, 28 September 1962 - 1000L - Flight briefing for tanker and receiver personnel involved in the daily program.

1300 - TOT for tanker

1306 - TOT for receivers

1800 - Debriefing and data collection

MISSION TIMETABLE

NOTE: Each receiver will execute a disconnect and re-hookup at 33,300 pounds (2,000 pounds external, 9,600 pounds total) and 35,100 pounds (3,700 pounds external, 11,400 pounds total).

Takeoff Time and Event		Pounds
TOT:	Tanker -- Weight	268,000
TOT + 28:	Level Off, 175 mi/1,300 lbs	252,000
TOT + 06:	F-100F	35,600
	F-100D	35,300
TOT + 28:	Level Off, 130 mi/3,000 lbs	32,600
TOT + 33:	Rendezvous and Position 5 Min	500
TOT + 33:	Pedal 11 Commences Refueling	
	Tanker Burns	1,500
	Receiver Burns	600
	Receiver Offloads	4,100
	Tanker Weight @ End 6 min	246,400

NOTE: Prior to the second refueling Pedal II will burn fuel down to internal fuel remaining (26 minutes total to include 5.5 minutes of A/B).

Takeoff Time and Event		Pounds
TOT + 39:	Pedal 12 Commences Refueling	
	Tanker Burns	1,500
	Receiver Burns	600
	Receiver Offloads and Loiter Fuel	4,100 + 600 (4,700)
	Tanker Weight @ End 6 min	240,200
TOT + 39:	4 Min Turn Required	
	Tanker Uses	1,000
	Fighter	400
	Tanker Weight @ End 4 min	239,800

Takeoff Time and Event		Pounds
TOT + 43:	Pedal 13 Commences Refueling	
	Tanker Uses	1,500
	Receiver Offload	5,200
	Tanker Weight @ End 6 min	233,100
TOT + 49:	Pedal 14 Commences Refueling	
	Tanker Uses	1,500
	Receiver Offload	5,800
	Tanker Weight @ End 6 min	255,800
TOT + 55:	Tanker Climbs, Turns and Offloads (dumps) to Simulate 1 Hour Cruise	15,000
	Tanker Weight	210,200
TOT + 59:	Completed 4 minute Turn	210,200
TOT + 59:	Pedal 11 Gommences Second Refueling	
	Tanker Uses	1,200
	Fighter Offloads	4,900
	Tanker Weight @ End 6 min Refueling	204,100
TOT + 1:05	Pedal 12 Commences Second Refueling	
	Tanker Uses	1,200
	Fighter Offloads	5,100
	Tanker Weight @ End 6 min	197,800
TOT + 1:11	Pedal 13 Commences Second Refueling	
	Tanker Uses	1,200
	Fighter Offloads	5,100
	Tanker Weight @ End 6 min	191,500

Takeoff Time and Event		Pounds
TOT + 1:17	Pedal 13 Commences Second Refueling	
	Tanker Uses	1,200
	Fighter Offloads	5,100
	Tanker Weight @ End 6 min	185,200
TOT + 1:23	Pedal 14 Commences Second Refueling	
	Tanker Uses	1,200
	Fighter Offloads	5,100
	Tanker Weight @ End 6 min	188,900
TOT + 1:29	Pedal 11 and 12 Perform 30 Minute Test Program	
	a. Effect 20° flaps	
	b. Vary inboard tanker engines	
	c. Boom position	
	d. Changes in airspeed	
	Tanker Uses	6,000
	Tanker Weight @ End 30 min	182,900
TOT + 2:00	Tanker Dumps 17,500 Pounds and Climbs	164,400
TOT + 2:00	Pedal 11 Commences Third Refueling	
	Tanker Uses	1,000
	Fighter Offloads	4,900
	Tanker Weight @ End 6 min	158,500
TOT + 2:06	Pedal 12 Commences Third Refueling	
	Tanker Uses	1,000
	Fighter Offloads	4,900
	Tanker Weight @ End 6 min	152,600

Takeoff Time and Event		Pounds
TOT + 2:12	Pedal 13 Commences Third Refueling	
	Tanker Uses	1,000
	Fighter Offloads	4,900
	Tanker Weight @ End 6 min	146,700
TOT + 2:18	Pedal 14 Commences Third Refueling	
	Tanker Uses	1,000
	Fighter Offloads	4,900
	Tanker Weight @ End 6 min	140,800
TOT + 2:24	End Daily Test Program	

AIRCRAFT AND PILOT DATA

ACFT	CONFIGURATION	PILOT	TOTAL PILOT HRS	TOTAL F-100 HRS	CALL SIGN
25 SEP 62					
F 860	2/335	JOHNSON	1616	1200	PEDAL 11
D120	2/335 + PYLON	YOUNGBLOOD	1800	1300	PEDAL 12
F951	2/335 + PYLON	SULLIVAN	3777	789	PEDAL 13
D457	2/335	VINSON	1565	1150	PEDAL 14
26 SEP 62					
F919	2/335	YOUNGBLOOD	1800	1300	PEDAL 11
D120	2/335 + PYLON	HAVEY	678	450	PEDAL 12
F951	2/335 + PYLON	HUGHES	1252	950	PEDAL 13
D121	2/335 + PYLON	STRESING	2456	1100	PEDAL 14
27 SEP 62					
F919	2/335	RICHMOND	1211	600	PEDAL 11
F120	2/335 + PYLON	STRESING	2356	1100	PEDAL 14
28 SEP 62					
F951	2/335 + PYLON	JOHNSON	1616	1200	PEDAL 11
D118	2/335 + PYLON	YOUNGBLOOD	1800	1300	PEDAL 12
F950	2/335	LIVENSPARGER	1195	700	PEDAL 13
D120	2/335 + PYLON	HAVEY	678	450	PEDAL 14

1. It should be noted that both pilots and aircraft included in the test program were chosen at random. A pilot experience cross section for each flight included one relatively inexperienced pilot (500 hrs), one of average experience (100-1500 hrs) and two highly experienced (2000 and over hrs). This cross section was achieved on all flights, however, it is not readily apparent under the tabulation of total hours. For instance, Richmond had

just recently returned to active duty after serving with the National Guard, where he accumulated reciprocating engine experience. Pilots participating were selected from all four squadrons in the 31st Tactical Fighter Wing.

2. Aircraft chosen at random were all assigned to the 31st Tac Ftr Wg, which trims its aircraft slightly below normal.

3. Each mission included a tanker crew that had not previously participated in the test program. A different tanker was used on each flight.

MISSION DATA

A. Mission #1 -- 1 KC-135, 2 F100D and 2 F100F aircraft. (Pedal 11 and 14, 2-335's -- Pedal 12 and 13, 2-335's ≠ Type VII Pylons)

1. Planned Objectives:

a. To determine maximum altitude that F100F/D can refuel without the use of afterburner from a KC135 tanker. Receivers will initiate a re-hookup at various fuel weights less than a full load condition.

b. Evaluate the effect of 20° of flaps.

c. Effect of varying tanker engine power by reducing the inboard engine power to a minimum, while maintaining planned airspeed.

d. Effects of varying the boom in length, azimuth and deflection.

e. Effects of varying the refueling tanker airspeed from 260 KIAS to 300 KIAS.

f. Effects of refueling at varying tanker gross weights.

2. Accomplishments:

a. Hookups were accomplished up to 28,000 ft without the use of afterburner; however, the receivers fell off prior to receiving a full load. No re-hook capability was possible. Temperatures averaged ≠ 10°C. above standard day. At 26,000 ft on a heavy tanker, receivers re-hooked with no considerable problem at 9600 lb and 11,400 lb internal fuel. However, re-hook at full load conditions proved marginal.

b. Flaps extended 20° at all airspeeds, from 260 KIAS to 300 KIAS, developed excessive drag and proved to be of no value.

c. The inboard engines were reduced to minimum power while maintaining maximum power (95%) on the outboard engines. No significant difference was noticed.

d. The boom was varied in length azimuth and deflection.

(1) Full length extension (19 ft) was most satisfactory because it placed the receiver at the lowest position where he received the least downwash effect from the tanker.

(2) Varying the azimuth from 6° left to 6° right had no effect on power available for refueling stabilization. However, pilots commented that 6° to the tanker's starboard was most satisfactory, since it placed the receiver directly in line with the tanker's fuselage, and presented a balanced sight picture.

(3) Full range deflection (38°) was most satisfactory because, coupled with the full length extension, it placed the receiver at the lowest position where he received the least downwash effect from the tanker.

e. During the maximum power required refueling situation, tanker indicated airspeed was varied from 260 KIAS to 300 KIAS. Throughout the speed range very little receiver power advantage was noticed, however, at 290 KIAS more power was available. The increased angle of attack of the receiver offset the reduced power required for lower airspeed. It was determined that at 290 KIAS, rather than 300 KIAS, there was increased stability of both the drogue and the receiver aircraft and 1% more engine power was available.

f. Four receivers were refueled at tanker gross weights of 240,000 lb, 200,000 lb and 160,000 lb. It was determined that 1,000 ft increase in altitude between each of the aforementioned tanker weights resulted in identical receiver control conditions.

3. Mission Findings:

a. Optimum position for the boom is: maximum deflection, 38° down; 6° azimuth to the tanker's starboard and fully extended, 19 ft.

b. Optimum tanker refueling airspeed is 290 KIAS; however, no appreciable control difference exists at any airspeed ranging from 260 KIAS to 300 KIAS.

c. If the drogue commences excessive oscillation, it may be stabilized by cycling the boom to the fully retracted position and then back to fully extended.

d. Onload capability of the tested aircraft varied considerably. At initial hookup, transfer rates varied from 750 PPM to 1800 PPM. As the receivers increased their fuel loads, the transfer rates averaged very close to 400 PPM during the final 1500 lb of onload. Onloads averaged 1000 PPM; however, this varied considerably with various aircraft. Fuel burned by the receivers during the non-afterburner refueling operation averaged 100 PPM.

e. It was evident that optimum mission accomplishment was hindered somewhat due to lack of understanding on both the part of the tanker pilots and the receiver pilots.

(1) Receiver pilots are not thoroughly familiar with the systems operations of the tanker. The boom operator controls only the position of the boom from reference to three indicator gages that show extension, azimuth and elevation of the boom.

(2) Actual fuel transfer is controlled from the front cockpit position, normally by the co-pilot. He has three gages for reference: a flow rate gage; a total fuel remaining aboard the tanker gage; and an off-load gage, which is manually reset to zero at the completion of each receiver offload. In addition to these gages, he controls both the transfer and the rate of transfer by selection of various transfer pumps. Maximum offload capability is approximately 6000 PPM. It was determined that minimum output (two pumps operational) was most satisfactory for refueling of the F-100 aircraft. This minimum output will exceed the on-load capability of any F-100 aircraft. Any output in excess of this tends to "blow" the receiver off or prematurely force a disconnect.

(3) Lack of radio discipline caused a major area of confusion. Receiver pilots do not recognize the fact that four different agencies within the tanker are transmitting on interphone during the refueling operation; the pilot, the co-pilot, the navigator and the boom operator. It is imperative that every transmission be preceded by a call sign.

(4) The co-pilot has no indication when a receiver has made contact and is stabilized for refueling. This must be called by the receiver.

(5) Generally, tanker pilots are too abrupt during any throttle change. The KC-135 has a great advantage over the F-100 in power to weight ratio. The tanker throttles must be "milked" ever so gently during any change, to enable the F-100 receiver to respond accordingly. When the receiver is stabilized and receiving fuel, airspeed should be sacrificed for power changes. This was especially evident during turns. This technique allowed for turns up to 20° of bank, without changing the established receiver's power.

f. Partial flaps are of no value during high altitude refueling within the speed range of 260 KIAS to 300 KIAS.

g. Varying inboard tanker engine power appeared to have no influence on the refueling operation.

4. Overall Mission Analysis: The mission was highly successful. Information outlined in Mission Findings will be invaluable for the establishment of more detailed refueling procedures and guidance than exist at the present time. It was determined that non-afterburner refueling at altitudes above 24,000 ft (the present restriction outlined in TACM 55-15, SACM 55-9) is not only possible, but will increase considerably the mission capability of the F-100 aircraft. During this first test program the aircraft were fully refueled at altitudes up to 28,000 ft. However, these altitudes, under the existing temperatures, are considered too high for operational purposes. At this time, the temperature, rather than a standard altitude figure, appears to be the controlling factor governing the optimum refueling altitude. There are two unknown factors that presently exist: (1) the

optimum altitude possible for refueling during standard day temperature conditions; and (2) what deviations from this altitude are caused by temperature changes. Future missions will be planned to solve these unknowns.

B. Mission #2 -- 1 KC-135, 2 F-100D and 2 F-100F aircraft. (Pedal 11, 2-335's and Pedal 12, 13 and 14, 2-335's ≁ Type VII Pylon).

1. Planned Objectives:

a. To correlate the effects of temperature with the optimum refueling altitude of the F-100 aircraft.

b. Re-evaluate the findings of Mission #1.

2. Accomplishments:

a. The mission program called for refueling at 26,000, 27,000 and 28,000 ft at heavy, medium and light tanker loads, respectively. Intentional disconnects and re-hookups were to be accomplished by the receivers at 10,000 lbs and 12,000 lbs (full load). Temperatures at the prescribed altitudes averaged ≁ 13°C. above standard day and ≁ 3°C. above the Mission #1 average. At 26,000 ft the receivers had no difficulty taking on fuel up to 10,000 lbs and disconnecting; however, a re-hook at 10,000 lbs exceeded the aircraft capability. During the previous day's mission, at temperatures 3° cooler, no problem was encountered at virtually this same load. Altitudes were increased to 26,500 and 27,500 ft as the tanker fuel load decreased, rather than the planned 27,000 and 28,000 ft. This deviation of 500 ft was still insufficient to make up for the difference in temperature; however, 1000 ft closely simulated the previous day's operation. Once again, these altitudes did not allow for dependable re-hookups at the receiver's full load condition, indicating that the test was exceeding the capability of the receiver for the existing conditions.

b. Tanker engine power was varied during maximum control conditions. No effect was noted. This supports the findings of Mission #1.

c. The boom position was varied. All assumptions formulated during Mission #1 were proven correct.

d. Refueling at 290 KIAS was once again most satisfactory.

e. One thousand foot increase in altitude for the prescribed decreased tanker fuel load was proven correct.

f. Receiver and tanker pilots were specifically briefed on radio discipline and tanker systems operations prior to the mission. Improved air discipline and tanker-receiver cooperation was quite obvious.

g. A total of 69 hookups was accomplished during the mission.

3. Mission Findings:

a. Boom position - same findings as Mission #1.

b. Refueling airspeed - same findings as Mission #1.

c. Fuel transfer rate - same findings as Mission #1.

4. Overall Mission Analysis: The mission was successful. Mission findings during Mission #1 were further substantiated. It was found that under the existing test conditions, 3° temperature variation represents approximately 1000 ft of altitude deviation. No basic standard day refueling altitude has been determined; however, the altitudes used during the completed tests exceed the capability of the aircraft under existing test conditions.

C. Mission #3 -- 1 KC-135, 2 F-100F aircraft. (Pedal 11, 2-335's and Pedal 14, 2-335's ≠ type VII Pylon).

1. Planned Objectives:

a. To continue correlation of temperature with optimum refueling altitude of the F-100 aircraft.

b. To employ confirmed procedures derived from Missions #1 and #2 during nighttime operations.

c. To test the feasibility of using a "toboggan" when the receiver approaches the point of maximum power control.

2. Accomplishments:

a. Only two aircraft were available for the mission. Both of these were F-100F's.

b. The mission called for refueling at 26,000, 27,000 and 28,000 ft at heavy, medium and light tanker loads, respectively. Receiver disconnects and re-hookups were to be accomplished at a full load condition only. This was to reduce pilot fatigue during the nighttime operation.

c. Temperatures averaged ≠ 14° above standard day temperatures. No problem was encountered while taking on a full load; however, re-hookup was difficult due to a maximum power condition. Once again, the 1000 ft between tanker gross weight conditions presented the receivers with identical control characteristics.

d. At 29,000 ft the receiver onloaded until fall off became imminent. A "toboggan" was initiated by reducing tanker power and establishing a 300 FPM descent. The technique proved to be successful and a full load was taken on with no problem. The identical procedure was used while refueling from 31,000 ft. A full load was taken on by two receivers with no problem. Total altitude lost while refueling both receivers was 3,300 ft.

3. <u>Mission Findings</u>:

a. Specific mission briefings are mandatory.

b. Optimum refueling airspeed is 290 KIAS on the tanker. However, during turns or during a toboggan, airspeed becomes secondary and may be depleted down to 260 KIAS.

c. Optimum boom position is full extension (19 ft), full elevation deflection (38°), and 6° azimuth to the tanker's starboard.

d. Receiver onload rate averages 1000 PPM.

e. The toboggan technique is very effective and insures a full onload at much higher altitudes than is possible during straight and level flight.

D. <u>Mission #4</u> -- 1 KC-135, 2 F-100F aircraft and 2 F-100D aircraft (Pedal 13, 2-335's, Pedal 11, 12 & 14, 2-335's ≠ type VII Pylon).

1. <u>Planned Objectives</u>:

a. After reducing all data collected during Missions 1, 2 and 3, it was found that the information could be applied directly to the flight tested performance charts contained in the F-100 Flight Handbook. By correlating the data and applying known information to the military thrust climb chart for the particular drag configuration being flown, any temperature, altitude and weight condition can be computed for any configuration. Substitution of weight for temperature enabled mission planning for a cross section of simulated temperatures. The Flight Handbook states that for each 10° temperature above standard day, 3000 lbs must be added to the gross weight when entering the chart. <u>The F-100 aircraft can receive a full load and reconnect, with surplus power available, at optimum cruise altitude. This altitude is indicated for the total weight and temperature condition in the appropriate military thrust climb chart.</u>

b. The mission was to be flown utilizing predetermined receiver weights to represent temperatures: standard plus 10°; standard; and standard minus 10° at the appropriate altitude indicated.

(1) The actual lower refueling altitude temperature for the daily mission was considered to be ≠ 12.5° above standard. Twenty-three thousand feet was computed as the maximum altitude for a full receiver fuel load under this condition. All receivers should be able to fully onload at 23,000, disconnect and re-hook. Note that this was to be accomplished at the heavy tanker gross weight, where the most severe downwash effect is encountered.

(2) The actual medium refueling altitude temperature for the daily mission was considered to be + 12.5° above standard. Reducing the total fuel load to 9000 lbs (F-100F) and 9300 lbs (F-100D), respectively, would represent a reduction of virtually 10° in temperature, or simulate a near standard day full load. Considering this simulation, 27,000 ft was computed to represent the optimum altitude that a full onload and re-hook could be accomplished at 2.5° warmer than a standard day.

(3) The actual high refueling altitude temperature for the daily mission was considered to be + 10° above standard. Reducing the total fuel load to 6000 lbs (F-100F) and 6300 lbs (F-100D), respectively, would represent a reduction of virtually 20° in temperature, or simulate 10° cooler than standard day full load. Considering this simulation, 30,200 ft were computed to represent the optimum altitude that a full onload and re-hook could be accomplished at 10° cooler than a standard day.

c. Techniques to be used during a toboggan were to be finalized. Refueling four F-100's by use of the toboggan method was to be accomplished.

2. Accomplishments:

a. Due to altitude clearance restrictions, three aircraft were forced to refuel at 24,000 ft, rather than the planned 23,000 ft. They encountered difficulty during the re-hook at full load. Pedal 14 accomplished his program at 23,000 ft with no problems encountered. He had approximately 1% of power remaining when stabilized and fully loaded.

b. The 27,000 ft tests were accomplished as planned and the results were exactly as anticipated.

c. The 30,200 ft tests were accomplished as planned, and the results were exactly as anticipated.

d. During the three aforementioned tests, pilots reported 1% or more remaining when stabilized on the drogue with a full load. This is a very significant factor.. The temperatures for the mission averaged + 17° warmer than standard. The mission was planned for + 12.5°. The + 4.5° difference represents approximately 1500 ft of altitude, which means that the preplanned mission was completely successful as flown at 1500 ft above the computed optimum refueling altitude.

e. The flight was taken to 33,000 ft. The average fuel load was 4500 lbs remaining on each receiver. Pedal 11 initiated a contact in straight and level flight. When he approached maximum power, he called for a toboggan. A smooth power reduction was immediately initiated by the tanker and a 900 FPM descent was established. Extreme turbulence was encountered, but the receiver reported excellent control. Turbulence forced a disconnect at 10,600 lbs, 1400 lbs below maximum load. Re-hookup was accomplished with little problem. Full onload was accomplished at 28,000 ft and the tanker leveled and accelerated back to 290 KIAS. Pedal 12 contacted and refueled straight and level until a toboggan was necessary. 500 FPM was used and he completed refueling at 27,000 ft, where the tanker once again leveled and accelerated to 290 KIAS. During the refueling operation, Pedal 12, 13 and 14 experienced extremely turbulent air conditions. Pedal 13 did not call for his toboggan soon enough, and required 7 minutes to re-hook under the adverse flight conditions. Pedal 14 encountered no problems and all four aircraft were refueled at 24,000 ft. This altitude was still 2000 ft above the full load optimum cruise altitude computed for the existing conditions.

3. Mission Findings:

a. Given a temperature, weight and aircraft configuration, exact optimum refueling altitudes can be computed from the appropriate military power climb chart in the Flight Handbook and adjusted for various tanker gross weights.

b. By use of the toboggan refueling method, optimum cruising altitudes can be planned for and utilized to insure maximum mission capability of the receiver aircraft.

c. The mc. an aircraft exceeds its optimum cruising altitude, the greater must be the rate of descent during the initial stages of toboggan refueling. The reason for this is that the onload rate exceeds the altitude loss capability in order to maintain a standard flight condition during the descent.

d. It is logical to assume that improved capabilities derived from this test will also apply to any fighter aircraft in our present inventory.

OVERALL TEST ANALYSIS

1. The flying portion of this test program was conducted on four successive days. Four KC-135 sorties and fourteen F-100 sorties were flown. Included was one night mission.

2. Positive factors:

a. Temperature is the most influential single factor that controls the maximum altitude for non-afterburner refueling.

b. The existing refueling techniques and directives outlined for the F-100, restrict the total capability of the aircraft. Flight tested techniques and procedures developed during this test program provide guidance for optimum flight planning when air-to-air refueling is a mission requirement. Sufficient latitude has been included to allow for combinations of deficiencies as a result of aircraft performance, pilot experience or flight conditions.

c. Onload tests were performed at three tanker gross weights to solve the relative tanker downwash factor. In this report, these weights are referred to as heavy, medium and light (240,000 lbs, 200,000 lbs and 160,000 lbs). Data collection contained in this report includes reference to total tanker fuel load. Gross weight is derived by adding 105,000 lbs (tanker aircraft weight) to this figure. From flight test data it was determined that the military power optimum refueling altitude increases linearly 1000 ft between heavy, medium and light tanker weight conditions.

d. Refueling at any tanker airspeed from 260 KIAS to 300 KIAS required virtually the same power and aircraft control; however, 290 KIAS was determined to be the most suitable. Because of this flexible speed range, airspeed is considered a secondary factor during a refueling transfer. Each transfer should be initiated at 290 KIAS, but tanker power should not be increased after contact is stabilized, or a disconnect will most likely occur. Airspeed should be sacrificed during tanker attitude changes, such as in turns or in toboggans. The tanker pilots were generally found to use abrupt power changes that exceeded the capability of the F-100 aircraft. Proposed toboggan techniques require very gentle power reductions by the tanker pilots.

e. The boom should be extended at full length, 19 ft; at full deflection, 38° down; and deflected in azimuth 6° to the tanker's starboard side. This places the receiver in the lowest relative position where the least downwash is encountered. The azimuth deflection places the receiver directly in line with the tanker's fuselage and presents a balanced sight picture.

f. Receiver pilots require additional instruction on tanker systems operations. Obvious lack of knowledge on the part of the receivers during the test program resulted in unnecessary confusion. Areas requiring specific emphasis are:

(1) Receiver pilot's responsibilities.

(2) Boom operator's responsibilities.

(3) Pilot and co-pilot responsibilities.

(4) Fuel transfer operation.

(5) Necessity for strict radio discipline.

A training program requiring all receiver pilots to fly one mission aboard a KC-135 would greatly enhance mission proficiency.

g. Considering temperature, weight and configuration, any optimum military power refueling altitude can be obtained from the appropriate military power climb chart contained in the Flight Handbook. This is accomplished by considering the maximum weight of the aircraft at the required fuel load specified. This weight must be adjusted for the forecast temperature condition at the refueling point (3000 lb increase or decrease for each 10° deviation from standard day). Optimum refueling capabilities are directly proportional to the optimum cruise line specified in the climb chart, with one exception -- adjustment for tanker weight must be applied. Optimum refueling at the heavy tanker weight is 500 ft below the optimum cruise altitude, medium weight is 500 ft above the optimum cruise altitude and light weight is 1500 ft above the optimum cruise altitude. As a result of this up-to-date refueling concept, sound reasoning completely refutes the validity of the existing non-afterburner refueling directive. (Reference TACM 55-15, SACM 55-9, page 16, para 2a, quoted below):

> "Performance. Recommended operational planning altitude for initial contact and refueling F-100 D/F aircraft is 28,000 feet and 300 tanker KIAS when equipped with two 450 gallon tanks and 31,000 feet and 300 tanker KIAS when equipped with 335 gallon tanks. All refueling above 24,000 feet will be accomplished using afterburner and partial speed brakes (15-17 inches). The F-100 D/F aircraft can onload a full fuel load without using afterburner at 24,000 feet or below at an airspeed of 300 tanker KIAS."

For a specific thrust setting, Mach number, and pressure altitude, there is a drastic change in thrust with changes in ambient temperature. This temperature is not considered in any of our existing refueling directives or operational plans. For instance, a fully loaded F-100F at 31,000 ft, as directed in TACM 55-15, will be 7,500 ft above its optimum cruise altitude when the temperature is 10° above standard. It will be 2,750 ft above optimum under standard temperature conditions.

h. A very effective toboggan procedure has been developed from flight test results of this program. It affords a flight of receivers the opportunity to cruise climb or step climb, utilizing the maximum cruise performance of the aircraft. It also enables the receiver aircraft to refuel with military power from virtually any altitude by varying the rate of descent of the toboggan maneuver. By using a step descent, numerous aircraft can be completely refueled prior to reaching the optimum cruise altitude programmed for a full receiver. During a toboggan maneuver the first receiver contacts at straight and level flight and onloads until 1/2% to 1% of full power is required. He must call for a toboggan in sufficient time to prevent a disconnect (during the tests, most pilots had a tendency to delay too long). The tanker pilot immediately and <u>very gently</u> reduces the tanker power 1% on all engines. This provides the receiver with an immediate power advantage during the deceleration. The tanker then initiates a descent of 700 to 900 FPM. (The higher the altitude above optimum full load altitude, the greater is the required descent). During the descent, smoothness of control is primary. Power, airspeed and rate of descent may be varied at the receiver's request. At full onload the first receiver disconnects; the tanker levels and accelerates back to 290 KIAS. Succeeding receivers then contact and follow the same procedures. However, as altitude decreases, each receiver can onload more fuel prior to calling for a toboggan and less rate of descent is required. After all receivers are refueled, optimum cruise power for a full load condition must be selected and a slight descent must be continued until optimum cruise power will maintain straight and level optimum cruise flight conditions. This method of seeking the optimum cruise flight level is just the reverse of cruise climbing, while accomplishing the same results.

3. Negative factors:

a. The use of 20° of flaps at any airspeed between 260 and 300 KIAS resulted in too much drag to be of any value.

b. Varying the power on the tanker engines had no noticeable effect on receiver control during transfer.

c. Varying the boom azimuth from 6° port to 6° starboard had no effect on receiver control during transfer. Pilots prefer the starboard position, because it gives them a balanced sight picture.

MISSION PROFILE PLANNING

1. Conclusive results of the test program insure two accurate methods of mission profile planning, to include military power air-to-air refueling.

a. Limited altitude profile: If, due to airspace availability, restricted block altitudes prevent optimum cruise climb or step climb procedures, a mean optimum block altitude can be computed. In this case, the optimum refueling altitude computed from the appropriate military power climb chart will be the lower limit of the block altitude. The upper limit will be the mean altitude between the optimum cruise altitude for a full receiver, and the optimum cruise altitude computed for the weight condition at the following refueling point.

b. Maximum efficiency toboggan profile: To obtain the maximum range possible, a cruise climb profile must be planned. By using the toboggan method of refueling, the receiver simply follows a programmed optimum mission profile with respect to the aircraft weight and flight conditions. Since all refueling operations are conducted between the lower and upper optimum cruise levels, the mission is not restricted by maximum refueling altitude requirements.

2. Although this test was conducted for the F-100 aircraft, it can be assumed that the same principles prescribed for mission planning will apply for any type of receiver aircraft.

ALTITUDE TEMPERATURE CORRELATION

ALTITUDE	AVERAGE TEMP	HOMESTEAD AVERAGE TEMP	TEMP MIS. #1	TEMP MIS. #2	TEMP MIS. #3	TEMP MIS. #4
33,000	-50	-41	--	--	--	-35
32,000	-48	-38.5	--	--	--	--
31,000	-46.5	-36.5	--	--	-32	--
30,000	-44	-34	--	--	--	-28
29,000	-42.5	-32.5	--	--	-29	-26
28,000	-40.5	-30.5	-28	-27	-26	-24
27,000	-38	-28	-27	-25	-24	-22
26,000	-36.5	-26.5	-25	-23	-22	-19
25,000	-34	-24	--	-21	--	-16
24,000	-32	-21.5	--	--	--	-14
23,000	-30.5	-19.5	--	--	--	-12

(ALL TEMPERATURES IN DEGREES CENTIGRADE)

NOTE: All test conditions accomplished during Mission #4 averaged $+$ 17° above standard day temperature. By entering the Flight Handbook charts and compensating for this unusual temperature condition, each test result was exactly as planned. Refueling altitude for any temperature and weight condition can be derived from the flight test data contained in the handbook tables.

SAMPLE PROFILES

1. Limited Altitude Profile (Reference profile appendix #1)

a. Given:

(1)	Temperature	+2°C. above stand
(2)	F-100F + 2-335's + type VII pylon full fuel load	35,600 lbs
(3)	F-100F + 2-335's + type VII pylon minimum load (5000 internal)	28,300 lbs
(4)	Tanker refueling weights	240,000; 200,000; 160,000 lbs

b. Solution:

(1)	Add 20% of 3000 lbs to total weight for temp	600 lbs
(2)	Standard cruise ceiling, full load	27,400 ft
(3)	Standard cruise ceiling, minimum load	35,100 ft
(4)	Heavy weight refueling altitude (standard cruise ceiling -500 ft)	26,900 ft
(5)	Medium weight refueling altitude (standard cruise ceiling + 500 ft)	27,900 ft
(6)	Light weight refueling altitude (standard cruise ceiling + 1500 ft)	28,900 ft
(7)	Mean cruising altitude	31,250 ft

2. Maximum Efficiency Toboggan Profile (Reference profile appendix #2)

a. Given:

(1)	Temperature	+10°C. above stand
(2)	F-100F + 2-335's + type VII pylon full load	35,600 lbs
(3)	F-100F + 2-335's + type VII pylon minimum load (5000 lbs internal)	28,300 lbs
(4)	Tanker refueling weights	240,000; 200,000; 160,000 lbs

b. Solution:

(1)	Add 100% of 3000 lbs to weight for temperature	3,000 lbs
(2)	Standard cruise ceiling full load	23,500 ft
(3)	Standard cruise ceiling, minimum load	33,500 ft
(4)	Heavy weight refueling altitude (standard cruise ceiling -500 ft)	23,000 ft
(5)	Medium weight refueling altitude (standard cruise ceiling + 500 ft)	24,000 ft
(6)	Light weight refueling altitude (standard weight + 1500 ft)	25,000 ft

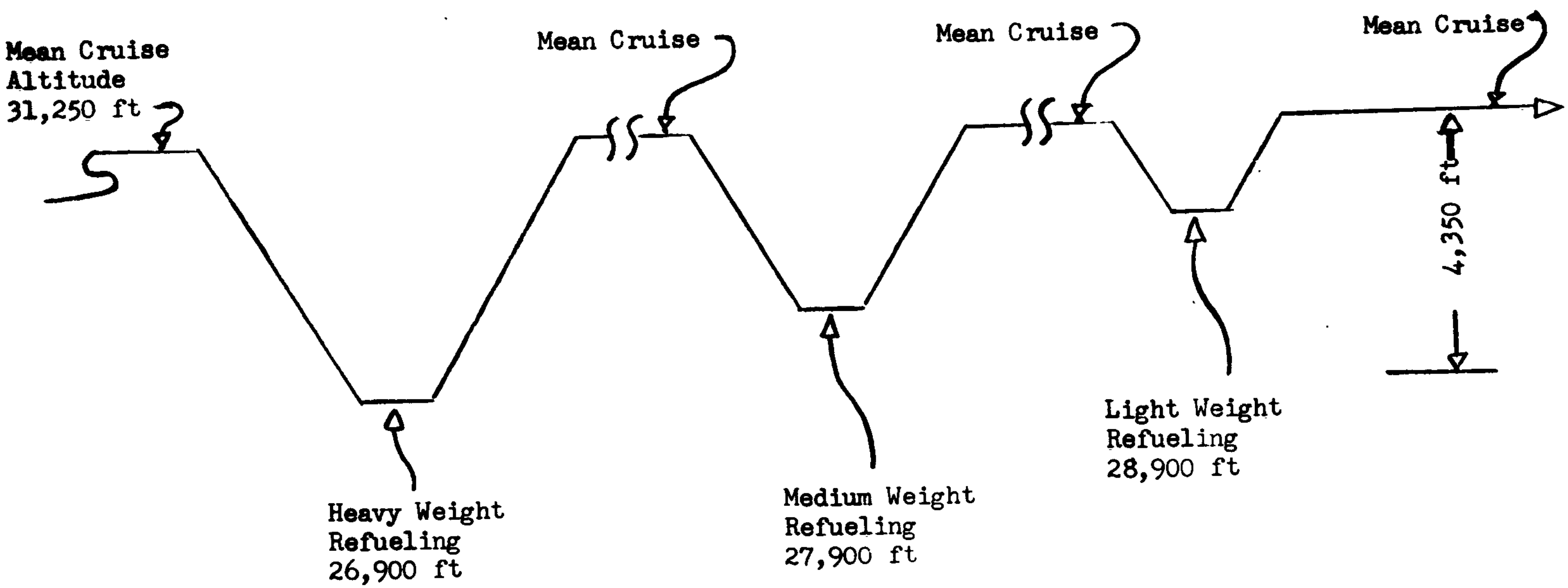
DISTRIBUTION LIST

HQ USAF	
AFORQ-TA	1
AFOOP-TA	1
AFMME	1
AFSSA	1
USAFE	
OTREQ	3
PACAF	
PFORQ	3
ASD	
TACSO-A	1
AFLC	
MCFLC	1
APGC	
TACLO-P	1
ESD	
TACSO-E	1
9 AF	3
12 AF	3
19 AF	1
837 AD	
TACT	1
ASTIA	
TIS	1
AU	
AUL3T	1
AGOS	
N-8	1
AFSC	1
BSD	
TACSO-B	1
AFSWC	
TACLO-S	1

USAFSAWC	1
836 AD	5
4440 Acft Dlvr Gp	1
4 TFW	1
354 TFW	5
31 TFW	5
832 AD	2
27 TFW	5
474 TFW	5
388 TFW	5
4510 CCr Tng Wg	3
831 AD	2
479 TFW	1
355 TFW	1
401 TFW	5
4520 CCr Tng Wg	3
17 AF	3
36 TFW	1
48 TFW	5
20 TFW	5
49 TFW	1
81 TFW	1
7272 ABW	1

50 TFW	5
5 AF	3
13 AF	3
8 TFW	5
18 TFW	5
405 TFW	5
41 AD	1
39 AD	1
313 AD	1
315 AD	1
314 AD	1
322 AD	1
366 TFW	5
HQ TAC	
DMEM	1
DOTR	1
DOOP	2
DIRQ	1
DOPL	3
DPLPR	1
DCRB	1
DMS	1
OIH	1
DOC	1
OA	1
OS	1
LN	2
DORQ-T	10
SEG	3

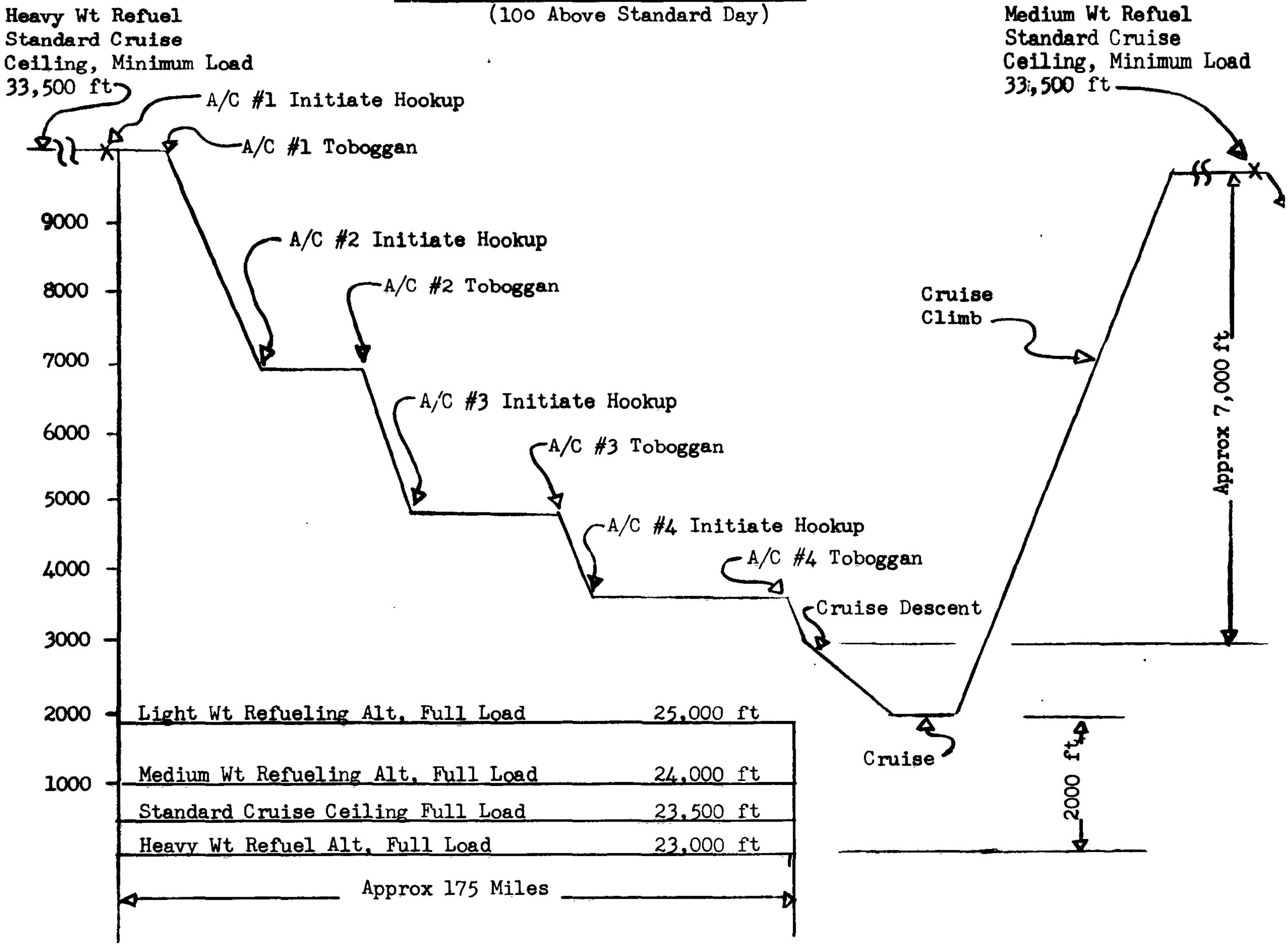
LIMITED ALTITUDE PROFILE



Appendix I

MAXIMUM EFFICIENCY TOBOGGAN PROFILE

(10o Above Standard Day)



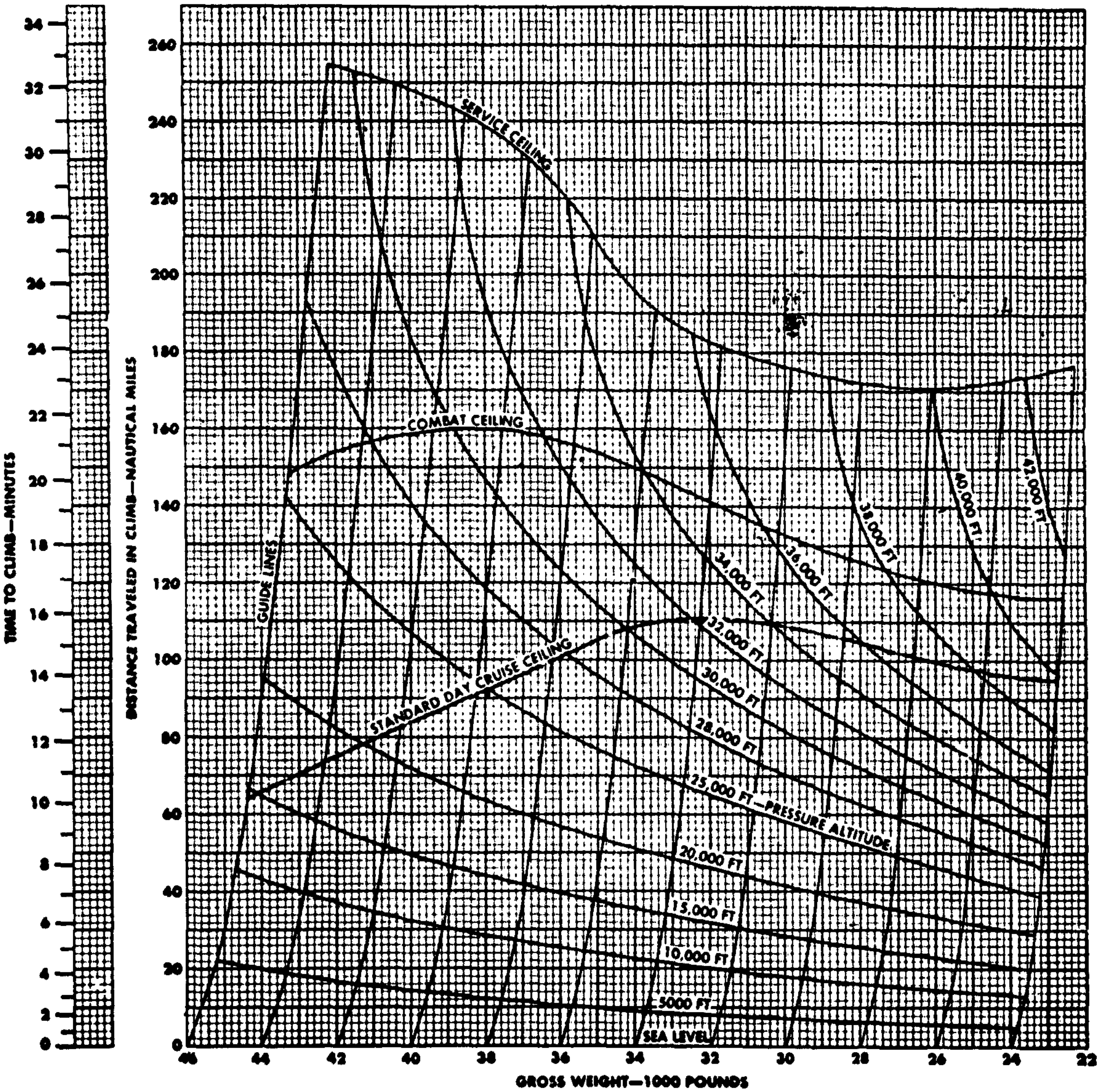
Appendix II

DATA AS OF: 1 OCT 1959
BASED ON: FLIGHT TEST

MODEL: F-100F
ENGINE: J57-21

MILITARY THRUST CLIMB

CONFIGURATION DRAG NO. 50

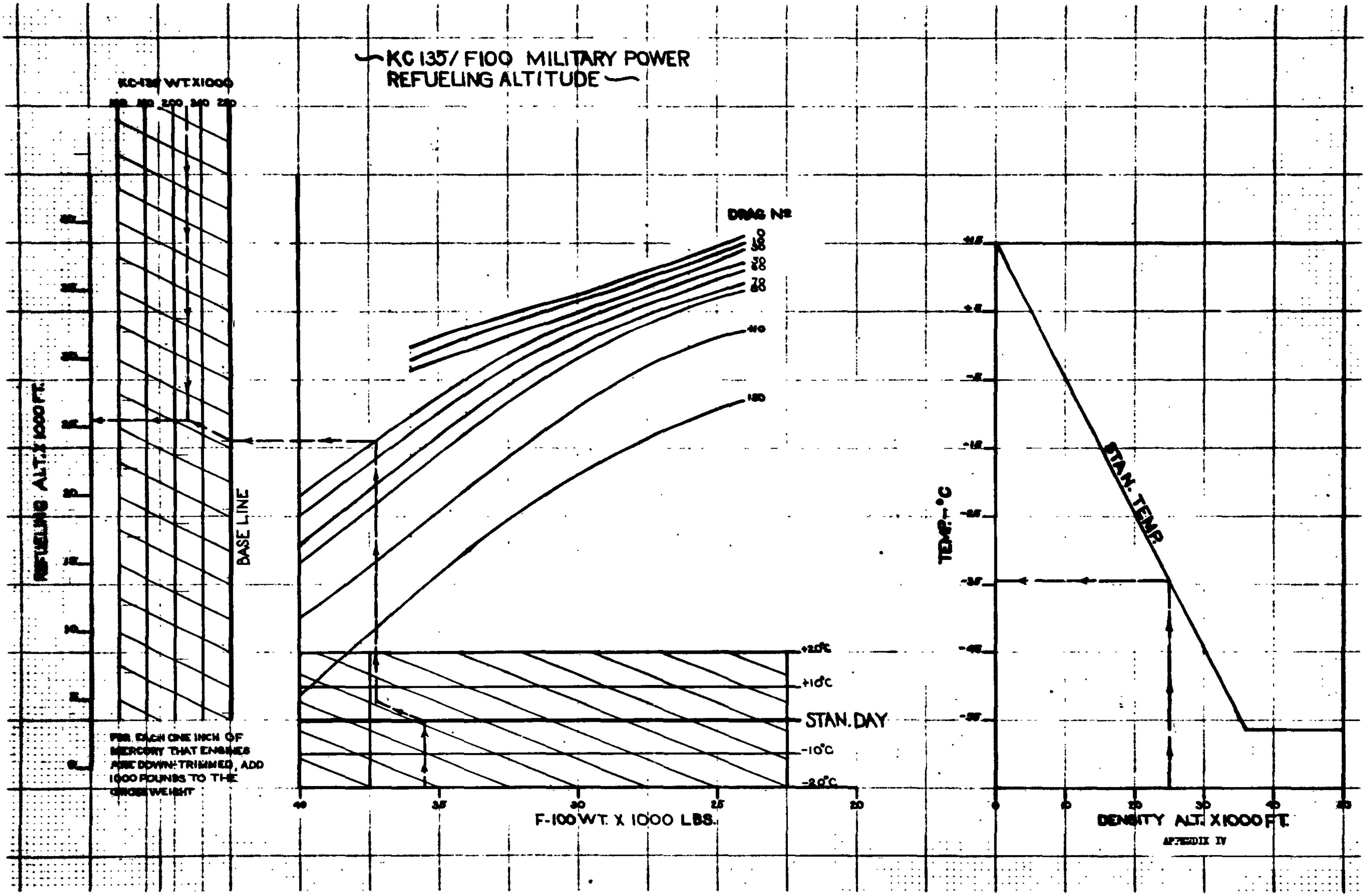


REMARKS:

1. FOR EACH 10°C RISE IN AIR TEMPERATURE ABOVE STANDARD DAY CONDITIONS, INCREASE GROSS WEIGHT 3000 POUNDS BEFORE ENTERING CHART.
2. FOR EACH 10°C BELOW STANDARD DAY CONDITIONS, APPLY CORRECTION IN THE OPPOSITE DIRECTION.
3. ALL DATA COMPUTED FROM TIME BEST CLIMB SPEED IS ATTAINED.
4. WHEN ENGINES ARE INTENTIONALLY DOWN-TRIMMED: FOR EACH ONE INCH OF MERCURY, ADD 1000 POUNDS TO THE CLIMB GROSS WEIGHT. THIS IS IN ADDITION TO THE TEMPERATURE CORRECTION DEFINED IN REMARKS 1 AND 2.
5. FOR CLIMB INITIATED IMMEDIATELY AFTER TAKE-OFF, SUBTRACT 1000 POUNDS OF FUEL FROM STATIC GROSS WEIGHT FOR START, TAXI, TAKE-OFF, AND ACCELERATION TO CLIMB SPEED, BEFORE ENTERING CLIMB CHART.

CLIMB SPEEDS			
ALTITUDE (FEET)	TRUE MACH NUMBER	IND MACH NUMBER	CAS (KNOTS)
50,000	.88	.85	215
45,000	.88	.85	240
40,000	.88	.85	270
35,000	.88	.85	300
30,000	.88	.85	335
25,000	.82	.79	345
20,000	.76	.74	355
15,000	.70	.68	355
10,000	.64	.62	355
5,000	.47	.46	285
SEA LEVEL	.30	.30	200

F-100F-1-93-30(B)


KC 135/ F100 MILITARY POWER
REFUELING ALTITUDE
KC-135 WT X1000
REFUELING ALT. X 1000 FT.
BASE LINE
FOR EACH ONE INCH OF MERCURY THAT ENGINES ARE DOWN-TRIMMED, ADD 1000 POUNDS TO THE GROSS WEIGHT
DRAG No
+20°C
+10°C
STAN. DAY
-10°C
-20°C
F-100 WT. X 1000 LBS.
STAN. TEMP.
TEMP. - °C
DENSITY ALT. X1000 FT.

APPENDIX IV

TEST DATA

CALL SIGN	A/C	MIN FOR TRANSFER	TOTAL FUEL TRANSF'D	RECEIVER FUEL AT DISCONNECT	TANKER FUEL AT DISCONNECT	HOOK-UP	FLIGHT CONDIT	ACT TEMP	STAND TEMP	DIFF	A/S	REMARKS
					26,000 FEET							
Pedal 13 Sullivan Schmidt	F 951	7 min	2350	9,600	133,000	#1	Smooth	-25°C	-36.5°	+11.5°	300	No Difficulties Executing Re-hook Smooth
Pedal 13 Sullivan Schmidt	F 951	5 min	3200	11,400	129,500	#2	IFR Rough Air	-25°C	-36.5°	+11.5°	300	Some Difficulties Over Control but Re-hooked
Pedal 13 Schmidt	F 951	-	-	Full	-	#3	Smooth	-25°C	-36.5°	+11.5°	300	Unable to Re-hook at Full Load Condition
Pedal 14 Vinson	D 457	3 min	3700	9,600	127,000	#1	Smooth In Turn	-25°C	-36.5°	+11.5°	300	Initially Rough but Smoothed Out - Re-hook Smooth
Pedal 14 Vinson	D 457	2 min	1500	11,300	123,500	#2	Smooth	-25°C	-36.5°	+11.5°	300	No Problem Re-hooking
Pedal 14 Vinson	D 457	-	-	Full	117,000	#3	Smooth	-25°C	-36.5°	+11.5°	300	Re-hooked with Full Power In Turn
Pedal 11 Youngblood Johnson	F 919	4 min	1800	10,000	146,000	#1	Smooth	-22°C	-36.5°	+14.5°	300	Re-hooked but pushed Off -Finally Got On
Pedal 11 Youngblood	F 919	3 min	2400	Full	140,000	#2	Smooth	-23°C	-36.5°	+13.5°	290	Full Power to Remain On
Pedal 12 Havey	D 191	3 min	2600	10,000	136,000	#1	Smooth	-23°C	-36.5°	+13.5°	300	Rough On Controls But Stayed On
Pedal 12 Havey	D 191	-	-	-	130,000	#2	Smooth	-23°C	-36.5°	+13.5°	300	Very Rough On Controls No Hookup Accomplished

CALL SIGN	A/C	MIN FOR TRANSFER	TOTAL FUEL TRANSF'D	RECEIVER FUEL AT DISCONNECT	TANKER FUEL AT DISCONNECT	HOOK-UP	FLIGHT CONDIT	ACT TEMP	STAND TEMP	DIFF	A/S	REMARKS
					26,000 FEET							
Pedal 13 Hughes Sayre	F 951	3 min	2900	10,000	128,000	#1	Smooth	-22°C	-36.5°	+14.5°	300	Smooth
	F 951	-	-	-	126,000	#2	Smooth	-22°C	-36.5°	+14.5°	300	Over Controlling No Hookup
Pedal 14 Stresing	D 121	5 min	2700	10,000	123,000	#1	Smooth	-24°C	-36.5°	+12.5°	300	Very Smooth - No Problems
Pedal 14 Stresing	D 121	5 min	-	10,600	118,000	#2	Smooth	-24°C	-36.5°	+12.5°	300	Very Smooth - Good Hookup but Fell Off
Pedal 11 Richmond	F 919	3 min	4700	Full	137,000	#1	Smooth	-22°C	-36.5°	+14.5°	290	Took on Full Load Nc Re-hookup
Pedal 14 Stresing	F 120	4 min	5460	Full	130,000	#1	Smooth	-22°C	-36.5°	+14.5°	290	Took on Full Load No Re-hookup

CALL SIGN	A/C	MIN FOR TRANSFER	TOTAL FUEL TRANSF'D	RECEIVER FUEL AT DISCONNECT	TANKER FUEL AT DISCONNECT	HOOK-UP	FLIGHT CONDIT	ACT TEMP	STAND TEMP	DIFF	A/S	REMARKS
					26,000 FEET							
Pedal 13 Hughes Sayre	F 951	3 min	3000	10,000	88,000	#1	Smooth	-25°C	-37°	+12°	300	Very Rough on Controls
Pedal 13 Hughes	F 951	-	300	-	-	#2	Smooth	-25°C	-37°	+12°	300	Pilot Over Control No Re-hook
Pedal 14 Stresing	D 121	4 min	3100	10,000	84,000	#1	Rough Air	-24°C	-37°	+13°	300	Very Smooth - No Problem
Pedal 14 Stresing	D 121	2 min	1500	Full	80,000	#2	Rough Air	-24°C	-37°	+13°	300	Re-hooked Full Load No Problem
Pedal 14 Stresing	F 120		4600	Full	93,000	#1	Smooth	-24°C	-37°	+13°	290-275	Fell Off at Full Load - 500 lbs

CALL SIGN	A/C	MIN FOR TRANSFER	TOTAL FUEL TRANSF'D	RECEIVER FUEL AT DISCONNECT	TANKER FUEL AT DISCONNECT	HOOK-UP	FLIGHT CONDIT	ACT TEMP	STAND TEMP	DIFF	A/S	REMARKS
					27,000 FEET							
Pedal 11 Johnson Vinson	F 860	3 min	2800	9,600	104,000	#1	Smooth	-27°C	-38°	+11°	300	Hooked up in turn
Pedal 11 Johnson Vinson	F 860	3 min	3000	11,400	100,500	#2	Smooth	-27°C	-38°	+11°	300	No Problem Re-hooking
Pedal 11	F 860	-	-	Full	97,000	#3	Smooth	-27°C	-38°	+11°	300	No Re-hook at Full Load
Pedal 12 Youngblood	D 120	3 min	2500	9,600	97,000	#1	Smooth	-27°C	-38°	+11°	300	Hooked up No Problem
Pedal 12 Youngblood	D 120	3 min	2400	Full	93,000	#2	Smooth	-27°C	-38°	+11°	300	Pushed Off at Full Load-Unable Re-hook
Pedal 13 Schmidt Sullivan	F 951	-	3500	9,700	90,000	#1	Smooth	-27°C	-38°	+11°	300	Erratic Control-Fell Off (16 min to Hook)
Pedal 13 Schmidt	F 951	3 min	1200	Full	84,500	#2	Smooth	-27°C	-38°	+11°	300	Re-hooked at Full Load
Pedal 14 Vinson	D 457	2 min	2800	9,600	79,000	#1	Smooth	-27°C	-38°	+11°	300	Hooked up Very Smooth
Pedal 14 Vinson	D 457	4 min	3200	Full	74,000	#2	Smooth	-27°C	-38°	+11°	300	Disconnected at Full Power - No Reconnect
Pedal 11 Youngblood	F 919	3 min	3200	10,000	105,000	#1	Smooth	-25°C	-38°	+13°	290	No Problem Hookup

CALL SIGN	A/C	MIN FOR TRANSFER	TOTAL FUEL TRANSF'D	RECEIVER FUEL AT DISCONNECT	TANKER FUEL AT DISCONNECT	HOOK-UP	FLIGHT CONDIT	ACT TEMP	STAND TEMP	DIFF	A/S	REMARKS
					27,000 FEET							
Pedal 11 Youngblood Johnson	F 919	-	2500	Full	97,000	#2	Smooth	-25°C	-38°	+13°	290	Had Difficulty Making Hookup & could not Re-hook at Full Load
Pedal 12 Havey	D 191	3 min	3500	10,000	96,000	#1	Smooth	-26°C	-38°	+12°		Good Cont No Problem with Hookup
Pedal 12 Havey	D 191	2 min	1800	Full	91,000	#2	Smooth	-26°C	-38°	+12°		No Re-hook at Full Loa

CALL SIGN	A/C	MIN FOR TRANSFER	TOTAL FUEL TRANSF'D	RECEIVER FUEL AT DISCONNECT	TANKER FUEL AT DISCONNECT	HOOK-UP	FLIGHT CONDIT	ACT TEMP	STAND TEMP	DIFF	A/S	REMARKS
					27,500 FEET							
Pedal 13 Hughes	F 951	3 min	3300	10,000	58,000	#1	Smooth	-27°C	-39.5°	+12.5°	290	Good Smooth Hookup
Pedal 13 Hughes	F 951	-	3200	Full	54,000	#2	Smooth	-27°C	-39.5°	+12.5°	290	Rough on Controls- No Hookup Full Load
Pedal 14 Stresing	D 121	6 min	5900	Full	50,000	#1	Smooth	-27°C	-39.5°	+12.5°	290	Very Smooth-Took Full Load- No Re-hook Attempted
Pedal 11 Youngblood Johnson	F 919	4 min	5000	Full	41,000	#1	Mild Turbulance	-27°C	-39.5°	+12.5°	290	Fell Off at Full Load
Pedal 12 Havey	D 191	5 min	5200	Full	34,000	#1	Smooth	-26°C	-39.5°	+13.5°	290	Very Smooth -Took Full Load- No Re-hook Attempted

CALL SIGN	A/C	MIN FOR TRANSFER	TOTAL FUEL TRANSF'D	RECEIVER FUEL AT DISCONNECT	TANKER FUEL AT DISCONNECT	HOOK-UP	FLIGHT CONDIT	ACT TEMP	STAND TEMP	DIFF	A/S	REMARKS
					28,000 FEET							
Pedal 11 Johnson Vinson	F 860	2 min	2000	8500	147,000	#1	Smooth	-29°C	-40.5°	+11.5°	300	Fell Off -No Re-hook Capability
Pedal 12 Youngblood	D 120	2 min	2300	-	139,000	#1	Smooth	-29°C	-40.5°	+11.5°	300	Fell Off -No Re-hook Capability
Pedal 11 Johnson Vinson	F 860	3 min	4100	9600	59,000	#1	Smooth	-28°C	-40.5°	+12.5°	300	Smooth Hookup
Pedal 11 Johnson Vinson	F 860	4 min	2600	Full	53,500	#2	Smooth	-28°C	-40.5°	+12.5°	290	Full Load Easily Taken No Re-hook Capability
Pedal 12 Youngblood	D 120		3800	9600	45,500	#1	Smooth	-28°C	-40.5°	+12.5°	290	Hooked up in Turn Very Smooth
Pedal 12 Youngblood	D 120	3 min	2300	Full	41,000	#2	Smooth	-28°C	-40.5°	+12.5°	290	Full Load -No Re-hook Capability

HOOK UP	CALL SIGN	A/C	MIN FOR TRANS-FER	TOTAL FUEL TRANS-FER'D	RECEIVER FUEL AT RE-HOOK	TANKER FUEL	FLIGHT CONDIT	ALT	ACT TEMP	STAND TEMP	DIFF	A/S	REMARKS
						DATE 28 SEPT 62							
#1	Pedal 11 Johnson	F 951	3 min	4000	Full	145,000	Smooth	24,000	-14°C	-32°	+18°	290	Initial Hookup & Full Load Very Good Unable Re-hook at Full Load
#1	Pedal 12 Youngblood	D 118	6 min	4700	Full	137,000	Smooth	24,000	-14°C	-32°	+18°	290-274 In Turn	Initial Hookup & Full Load Very Good, No Re-hook at Full Load
#1	Pedal 13 Livensparger	F 950	6 min	4800	Full	131,000	Rough Air	23,000	-12°C	-30.5°	+18.5°	290 In Turn	Good Hookup & Full Load Re-hook with Full Load
#1	Pedal 14 Havey	D 120	5 min	5700	Full	123,000	Slightly Turbulent	23,000	-12°C	-30.5°	+18.5°	290	Two Re-hooks at Full Load with No Problem
#2	Pedal 11 Johnson	F 951	Simu-lated Load	- Full	Simu-late Full 9000#	116,500	Smooth	27,000	-22°C Sim -35°C	-38°	+3°	290	Good Hookup-Felt same as Full Load-Re-hooks accomplished easily
#2	Pedal 12 Youngblood	D 118	Simu-lated Load	- Full	Simu-late Full 9300#	111,000	Smooth	27,000	-22°C Sim -35°C	-38°	+3°	290	Good Hookup -Felt same as Full Load- Re-hooks accomplished easily
#2	Pedal 13 Livensparger	F 950	Simu-lated Load	Full	Simu-late Full 9000#	109,000	Smooth	27,000	-22°C	-38°	+3°	290	Good Hookup -Felt same as Full Load-Re-hooks accomplished easily
#2	Pedal 14 Havey	D 120	Simu-lated Load	Full	Simu-late Full 9000#	107,000	Smooth	27,000	-22°C Sim -35°C	-38°	+3°	290	Good Hookup -Felt same as Full Load- Re-hooks accomplished easily

HOOK UP	CALL SIGN	A/C	MIN FOR TRANS-FER	TOTAL FUEL TRANS-FER'D	RECEIVER FUEL AT RE-HOOK	TANKER FUEL	FLIGHT CONDIT	ALT	ACT TEMP	STAND TEMP	DIFF	A/S	REMARKS
						DATE 28 SEPT 62							
#3	Pedal 11 Johnson	F 951	Simu-lated Load	- Full	Simulate Full 6000#	105,800	Rough Air	30,200	-27°C Sim -52°C	-45.5° Sim -55.5°	+3°	290	Good Hookup- Felt same as Full Load -Re-hooks accomplished easily
#3	Pedal 12 Youngblood	D 118	Simu-lated Load	- Full	Simulate Full 6300#	104,000	Smooth	30,200	-29°C Sim -54°C	-45.5° Sim -55.5°	+1.5°	290	Good Hookup- Felt same as Full Load -Re-hooks accomplished easily
#3	Pedal 13 Livensparger	F 950	20 sec	1100	Sim Full -1000# 5000	102,000	Smooth	30,200	-31°C Sim -56°C	-45.5° Sim -55.5°	-.5°	290	Excellent Hookup -Rec 1000# & Re-hooked with No Problem
#3	Pedal 14 Havey	D 120	40 sec	1000	Sim Full -1000# 5300	100,000	Smooth	30,200	-31°C Sim -56°C	-45.5° Sim -55.5°	-.5°	290	Excellent Hookup -Rec 1000# & Re-hooked with No Problem
				TOBOGGAN, REFUELING 4 F-100's STARTING AT 33,000 FEET									
#4	Pedal 11 Johnson	F 951	11 min	(1)5800 (2)2300	10,600	98,200	Smooth	33,000 → 28,000	-35°C → -24°C	-50° → -40.5°	+15° → +16.5°	290 → 280	4 Min Re-hook After Dis-connect -Pilot Technique Average 800 FPS Descent
#4	Pedal 12 Youngblood	D 118	4 min	(1)7600	4,800	87,100	Very Rough Air	28,000 → 27,000	-24°C → -22°C	-40.5° → -38°	+16.5° → +16°	290 → 290	Excellent Control 400-600 FPM Descent
#4	Pedal 13 Livensparger	F 950	14 min	(1)5600 (2)2600	10,000	78,500	Very Rough Air	27,000 → 25,000	-22°C → -16°C	-40.5° → -34°	+18.5° → +18°	290 → 275	Did not call for Toboggan in time -Spent 7 min in Rough Air for Re-hook
#4	Pedal 14 Havey	D 120	5 min	(1)8200 (2) 230	11,900	67,800	Very Rough Air	25,000 → 24,000	-16°C → -13°C	-34° → -32°	+18° → +19°	290	Excellent control -Fell off due to Rough Air & Re-hooked No problem